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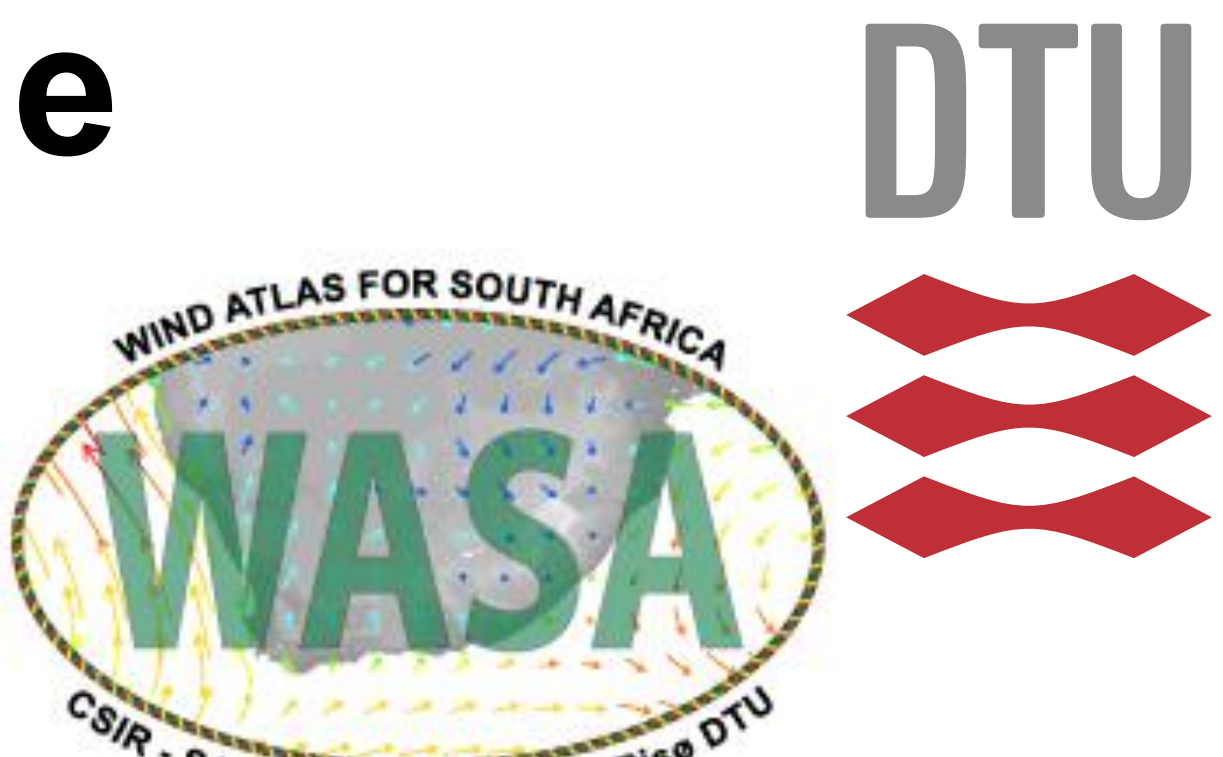
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Wind resource error estimation from mesoscale modeling for the Wind Atlas for South Africa

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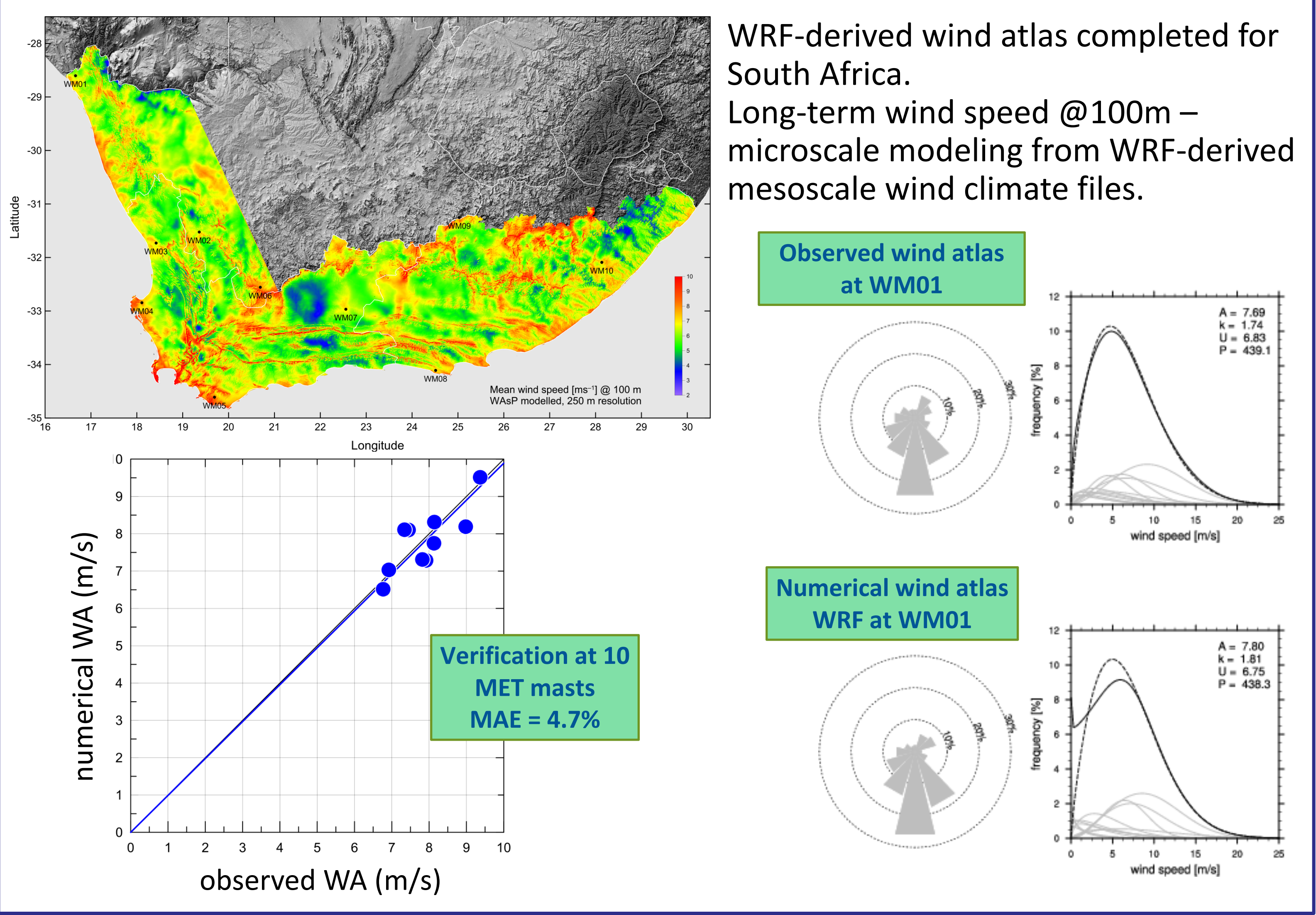
Abstract

We explore the utility of a new method for estimating the uncertainty of the wind resource based on an ensemble of WRF simulations. The output of the ensemble simulations can be processed to give a ‘map’ of the spread of the wind resource estimation. By comparing these ‘maps’ with the errors in wind speed at sites and by relating these to the terrain complexity and wind climate complexity, it might be possible to diagnose the geographic distribution of errors in the wind power resources away from the observation sites. We demonstrate this method here for the Wind Atlas of South Africa (WASA).

Introduction

The Wind Atlas for South Africa (WASA)¹ project created a wind atlas database of winds for the Western Cape and parts of the Northern and Eastern Cape. The atlas was verified against measurements from 10 wind masts², which were also part of the project, and gave a mean absolute error in wind speed of about 5% (see Figure below).

The verification errors are useful to assess the errors around the observation sites. But they only sample the large variety of wind climates and terrains across a few points. These provide an illustration of the range of errors and uncertainties that generally would be expected at similar sites. The objective of this work is to try to estimate the possible errors in wind resource made from the wind atlas at sites that are either far from verification masts or at sites of a different climate or topography. The methodology proposed below tries to address this issue.

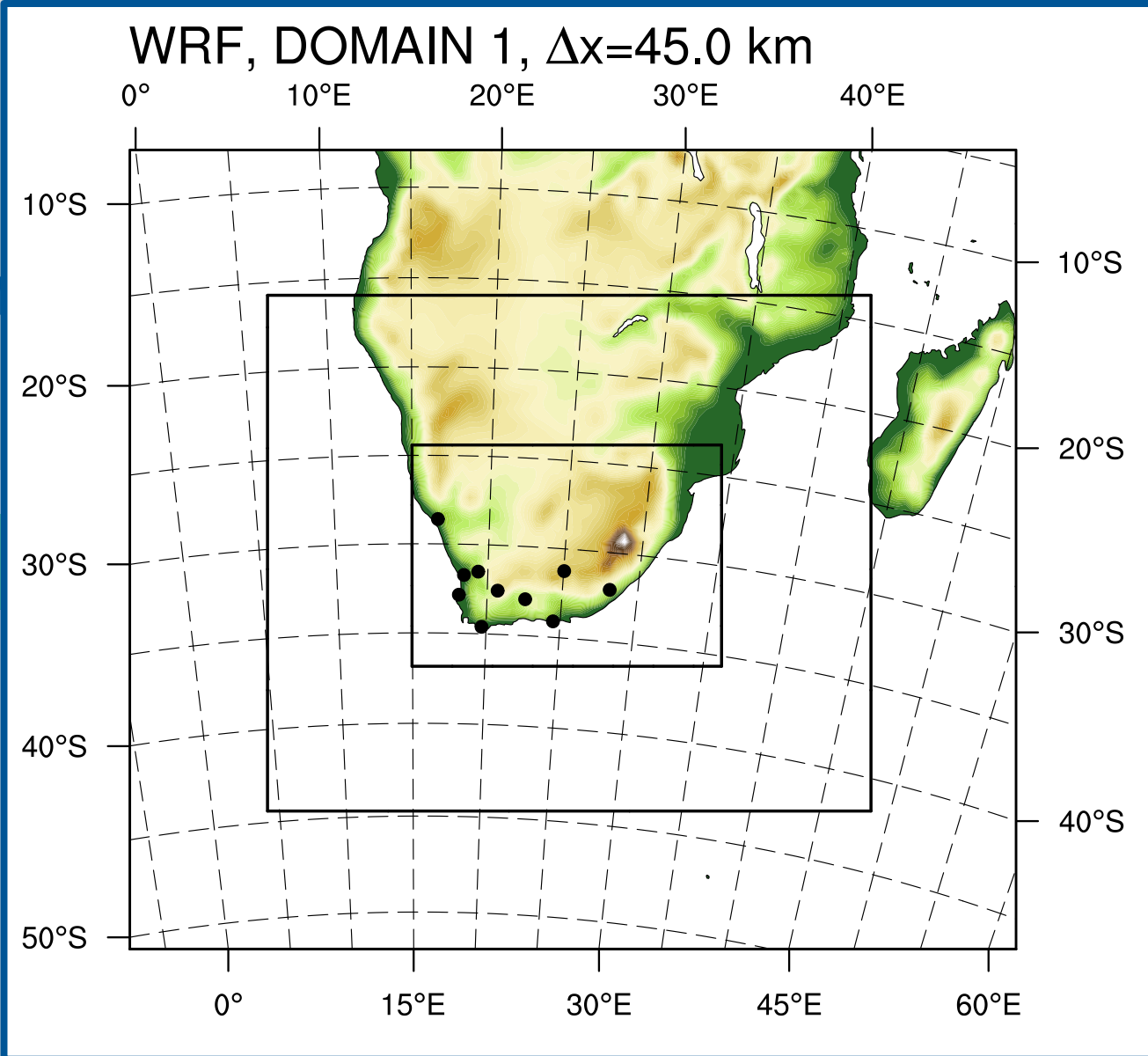


Methods

In an analogous way to what is done in numerical weather and climate prediction, we explore the possibility to estimate the uncertainty of the wind resource based on an ensemble of WRF simulations (Table 1).

We examine the results of a first ensemble of simulations combining multiple physics (PBL schemes), land initial conditions and simulation setup (see Table 2).

Table 1: WRF setup
45, 15 and 5 km x 5 km inner domain (see right)
ERA Interim forcing; MODIS landuse
High Resolution sea surface temperatures
WRF Version 3.8.1
One complete year: June 2012 to May 2013

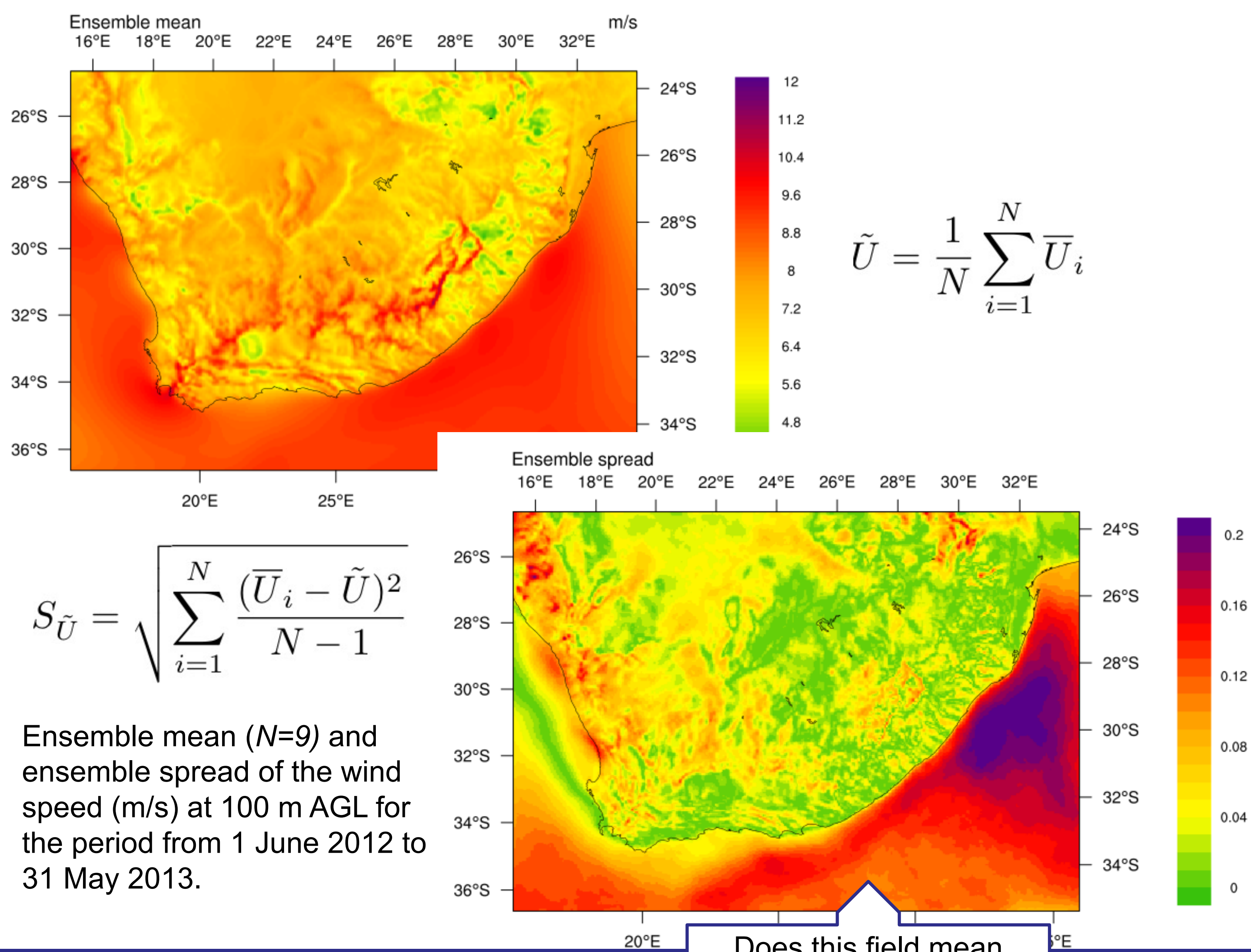
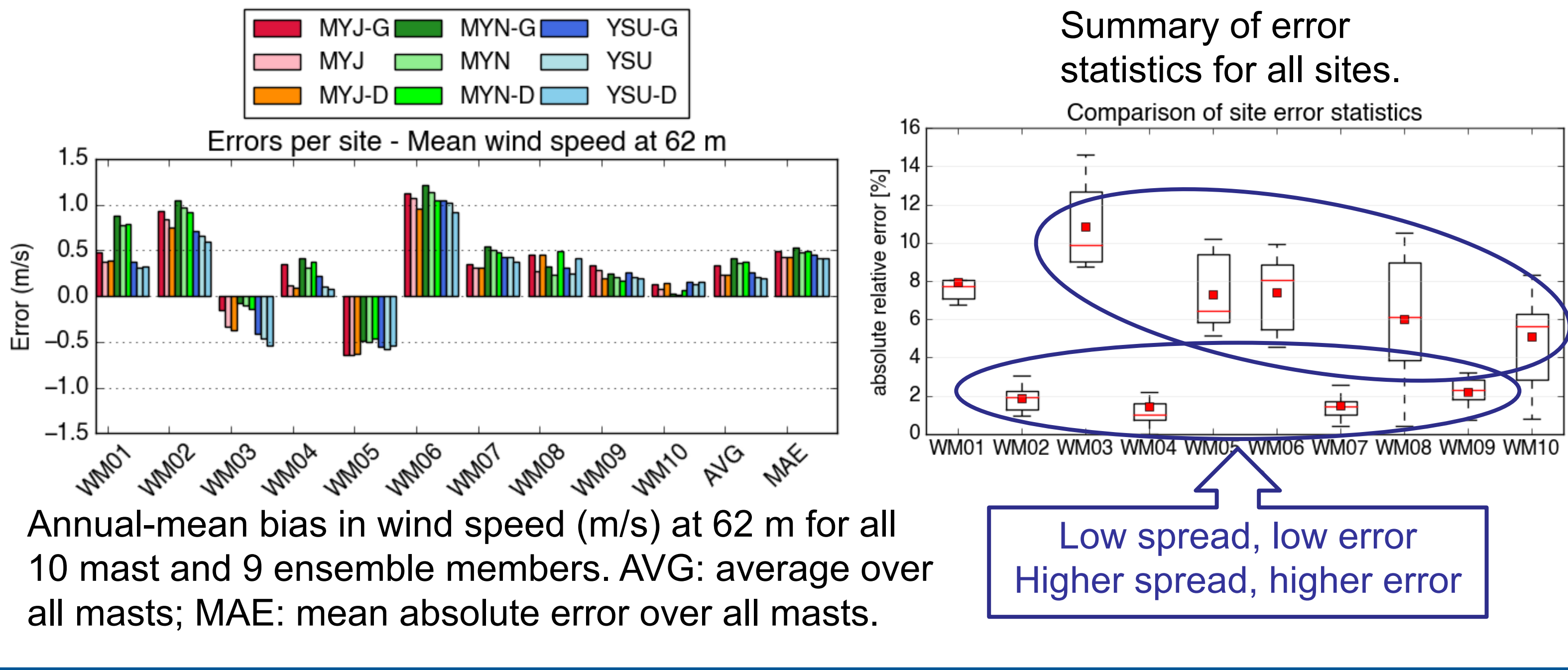


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Results

Table 2: WRF setup used in the ensemble simulations			
Experiment name	PBL scheme	Soil moisture source	Simulation length (days)
MYJ-G	MYJ	GLDAS ³	10
MYJ	MYJ	ERA-I ⁴	10
MYJ-D	MYJ	ERA-I	1
MYN-G	MYNN2	GLDAS	10
MYN	MYNN2	ERA-I	10
MYN-D	MYNN2	ERA-I	1
YSU-G	YSU	GLDAS	10
YSU	YSU	ERA-I	10
YSU-D	YSU	ERA-I	1



Conclusions and future work

- The results of the ensemble simulations are encouraging, but further analysis of the results is necessary to quantify how useful they are.
- The principal disadvantage of the use of the ensemble mean and spread of the simulations is that it can be misleading, and will not be the best estimate of the most accurate value and its uncertainty, if clusters of similar simulations outcomes exist, and the ensemble mean lies between those clusters.
- We need to find a method to quantify if two ensemble simulations are too similar decide if one should be removed from the set.
- The next step is also to identify potential statistical techniques (e.g. machine learning) to optimally combine the results from the various ensemble members into a single wind resource map.

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